Claims

I claim:

1. Apparatus for bending a tube in a tube bend plane, comprising:

a sleeve for receiving the tube therein

a bend die mounted for rotation about a bending axis

a clamp die directed toward the bend die for clamping the sleeve to the bend die, the sleeve having an inner surface engaged by the bend die and an outer surface engaged by the clamp die, the clamp die holding the sleeve to be bent as the bend die and clamp dies rotate about the bending axis

a pressure die engaged with the outer surface of the sleeve for restraining a portion of the sleeve spaced away from the bend to be formed in the tube; and

means for rotating the bend die and clamp die to bend the sleeve and tube about the bend die.

2. The apparatus of claim 1, wherein the sleeve has a first longitudinal slit located between the inner surface and the outer surface parallel to the tube bend plane

3. The apparatus of claim 2, wherein the sleeve has a second longitudinal slit located between the inner surface and the outer surface parallel to the tube bend plane.

4. The apparatus of claim 1, wherein the sleeve comprises carbon steel

5. A method for bending a tube, the tube having an outer diameter and the bend defining a tube bend plane, comprising:

inserting the tube into an external sleeve, the external sleeve having an inner surface and an outer surface;

engaging the inner surface of the sleeve with a bend die mounted for rotation about a bending axis;

engaging the outer surface of the sleeve with a clamp die for clamping the sleeve and a tube to the bend die;

directing a pressure die against the outer surface of the sleeve adjacent the clamp die; and

rotating the clamp die and the bend die to bend the sleeve and tube around the bend die.

6. The method of claim 5, wherein the sleeve has a first longitudinal slit located parallel to the tube bend plane between the inner surface and the outer surface of the sleeve.

7. The method of claim 6, wherein the sleeve has a second longitudinal slit located parallel to the tube bend plane between the inner surface and the outer surface of the sleeve opposite the first longitudinal slit.

8. The method of claim 5, wherein the sleeve is made of carbon steel.

9. The method of claim 5, wherein the tube is bent to a bend radius between about 1 to about 2 times the tube outer diameter.

10. The method of claim 5, wherein the tube has a tube wall thickness less than about 10% of the diameter of the tube.

11. The method of claim 10, wherein the tube is bent to a bend radius between about 1 to about 2 times the tube outer diameter.

12. The method of claim 5, wherein the tube has a tube wall thickness of about 0.095" - 0.250."

13. The method of claim 12, wherein the tube is bent to a bend radius between about 1 to about times the tube outer diameter.

14. A method for bending a tube into a tight radius bend, the tube having a tube

wall thickness less than about 10% of the tube outer diameter, the bend defining a tube bend plane, comprising:

inserting the tube into an external sleeve, the sleeve having an inner surface and an outer surface and a first longitudinal slit located parallel to the tube bend plane between the inner surface and the outer surface;

engaging the inner surface of the sleeve with a bend die mounted for rotation about a bending axis;

engaging the outer surface of the sleeve with a clamp die for clamping the tube to the bend die;

directing a pressure die against the outer surface of the sleeve adjacent the clamp die; and

rotating the clamp die and the bend die to bend the tube and sleeve around the bend die.

15. The method of claim 14, wherein the tube is bent to a bend radius between about 1 to about times the tube outer diameter.

16. The method of claim 15, wherein the sleeve has a second longitudinal slit located parallel to the tube bend plane between the inner surface and the outer surface opposite the first longitudinal slit.